Memorandum

To: Chris Hempleman
Cc: Dustin Bilhimer, Greg Pelletier, Kirk Sinclair, Lawrence Sullivan, Trevor Swanson, Karol Erickson
From: Mindy Roberts
Date: January 26, 2006
Subject: Deschutes River, Capitol Lake, Budd Inlet TMDL
Quarterly Progress Reports #10 and #11 (July through September 2005 and October through December 2005)

Introduction

The Deschutes River, Capitol Lake, Budd Inlet, and tributaries were placed on the 1996 and/or 1998 Clean Water Act Section 303(d) list of impaired waters based on historical monitoring by several organizations. In total, 24 water bodies have water quality parameter levels that do not meet standards for at least one of the following: temperature, fecal coliform bacteria, dissolved oxygen, pH, nutrients, or fine sediment. The TMDL study began in March 2003 to assess the current condition of the water bodies and to identify and quantify factors contributing to the impairments. The previous quarterly progress reports (July 31, 2003; December 1, 2003; February 9, 2004; April 15, 2004; August 30, 2004; October 29, 2004; February 28, 2005; and August 18, 2005) summarized the results of the 2003 and 2004 monitoring programs.

This memorandum summarizes the progress to date related to data collection, data analysis, modeling, and project communications.

Progress to Date

Temperature and Hydrogeology Data Collection

Project data collection concluded in December 2004. The water and air temperature data quality has been verified, and results can be downloaded from Ecology's web page (see below under Conventionals for details). Daily minimum, average, and maximum temperatures are available. Piezometer data, including vertical hydraulic gradients and temperatures, will be transferred to the Environmental Information Management (EIM) system during the next quarter and will be available with the rest of the study data.

Figure 1 presents the seven-day average of daily maximum temperature for the stations located on the main stem of the Deschutes River. Both in 2003 and 2004, the hottest stations were at Old Camp Lane and Riverlea. Only the station above the upper falls met the water quality standards for temperature. (Note that zero values were used to fill in periods that were not monitored.)

Figure 2 presents the seven-day average of daily maximum temperature for the stations on the tributaries to the Deschutes River. The Tempo Lake outflow and Reichel Creek did not meet the water quality standards for temperature in 2003. The Tempo Lake outflow was affected by a change in the lake outflow structure in September 2003, so the temperature regime reflects the hydrology as well as shade along the creek. Tributaries to the upper Deschutes River met the water quality standards, as did the three spring inflows. The tributary temperature monitoring was discontinued in 2004 (see discussion below).

Figure 3 presents the seven-day average of daily maximum temperature for the Percival Creek and Black Lake Ditch stations. The highest temperatures are where Black Lake Ditch leaves Black Lake; the peak ditch temperatures cool nearly 3°C by Jones Quarry and an additional 2°C at the confluence with Percival Creek. Percival Creek also cools in a downstream direction to the confluence with Black Lake Ditch. This part of Percival Creek met the water quality standards for temperature in 2003 but did not meet the standards in 2004.

The 2003 data will be used to calibrate and validate the temperature model for the Deschutes and Percival systems. For the Deschutes model, the hottest 7-day period will be used for calibration (July 27 through August 2, 2003), the coolest summer non-storm 7-day period will be used for validation (August 5 through 11, 2003), and the date of the thermal infrared flight will also provide model validation (August 20, 2003).

Only two springs were monitored for temperature in summer 2004; therefore, the period will not be used for model calibration but may be used for validation. The Quality Assurance Project Plan (QAPP) for the 2004 monitoring period was not clear on whether tributaries were to be instrumented. The report figures do indicate they were part of the monitoring network, but the text does not include the stations. Field staff used the text as guidance and no TidBits were installed. We will continue to evaluate alternatives for using the 2004 temperature dataset. Given that the flow and meteorology conditions were similar between 2003 and 2004, tributary temperatures may be reconstructed for 2004 conditions to provide additional model validation datasets. If the conditions cannot be reconstructed, then only 2003 data will be used for model calibration and validation. The mainstem 2004 temperature data are still extremely useful for characterizing patterns within the Deschutes River.

Table 1 summarizes river discharge for the historical and recent periods of interest. The E Street bridge gage record began in 1945 and the Rainier gage record began in 1949. Both records were discontinued between 1964 and 1991. The earliest gaging time period (1945-1964) coincides with a negative-phase Pacific Decadal Oscillation (PDO), a climate cycle affecting western Washington described in Mantua et al. (1997). Negative-phase PDOs are associated with higher-than-normal river discharges. The more recent gaging period (1991 through 2001) coincides with a positive-phase PDO, during which lower-than-normal river flows occur. Low-flow statistics reflect these patterns, and the recent 7Q10[1] values are 20 to 30% lower than the historical 7Q10 values. Summer 2003 and 2004 low flows are similar to 7Q10 conditions during the current positive PDO climate phase. The calibration and validation time periods, which were selected based on the temperature records combined with the discharge time series, did not necessarily occur during the absolute lowest-flow periods in 2003 and 2004.

Table 2 summarizes preliminary flow balances derived for the Deschutes under low-flow conditions in 2003. Most of the flow at the E Street bridge enters the system as groundwater downstream of the USGS Rainier gage (50 cfs of 79 cfs). Tributaries accounted for 13.7 cfs along the entire length. The remainder enters the system as groundwater upstream of Rainier or as otherwise unmonitored surface waters. The flow balances will be refined based on the network of piezometers to identify local groundwater fluxes.

Figure 4 presents provisional piezometer information. The vertical hydraulic gradients indicate whether the reach is gaining water from or losing water to groundwater. Losing reaches coincide with increasing river temperature. Reaches that gain cool water from groundwater, also as indicated by the vertical hydraulic gradient, exhibit a cooling trend. Overall, the piezometer network is consistent with seepage run patterns.

[1] 7Q10 refers to the 7-day average discharge that occurs, on average, once in 10 years.

Department of Ecology continues to maintain three temperature monitoring stations along the Deschutes River to evaluate long-term temperature patterns. The stations will remain in place following the completion of the TMDL study pending future staffing constraints. This is part of a long-term data collection initiative of the Environmental Assessment Program and not limited to the Deschutes study.

Two of the three extended monitoring stations on the Deschutes River have been retrofitted to include continuously recording water level loggers to measure the stage of water in the piezometer and the stream stage to derive a continuous vertical hydraulic gradient. These two sites are 13-DES-24.9 (Deschutes at the USGS gage) and 13-DES-33.5 (Deschutes at Tabor cabin). Several months of water level data have been collected and will be analyzed to determine the performance of these types of continuous water level logger deployments. Instream, air, and hyporheic temperatures are still being collected at these stations and barometric pressure has been added at 13-DES-33.5 to provide a correction factor for the water level loggers. These stations have not had any problems during the field checks and they made it through another summer without any vandalism.

Conventional Water Quality Parameter Data Collection and Planning

Routine monitoring concluded in December 2004. Ecology staff have completed data quality checks, and all project data are available under the Environmental Information Management (EIM) system accessed through Ecology's web page (http://www.ecy.wa.gov/eim/). Interested parties can download the entire project database by clicking on the *Search Database* link, then *Search by Study*, using the *User Study ID* = **MROB0001**. Alternatively, data can be found by location using the *Search by Map* capability, zooming in on the area of interest, selecting monitoring stations using the select box, then viewing the data; from this link, users can download monitoring station information as well as results. Data compilations will be included in future quarterly reports.

Stormwater Monitoring

Ecology continues to observe weather patterns, and we will monitor one more stormwater event. The winter weather patterns have not produced sufficient antecedent dry periods to qualify the storm events.

Communication and Coordination

- Developed materials for and participated in CLAMP walking field trip of Capitol Lake on October 27, 2005. Coordinated water quality information with Sue Davis (Thurston County)
- Discussed draft sediment report with Mary Raines (NWIFC, under contract to the Squaxin Island Tribe) on October 6, 2006.
- Provided project temperature data and channel cross-section information to Tracy Farrell (Squaxin Island Tribe) in December 2005.
- Attended annual CLAMP meeting on December 1, 2005.
- Contacted USGS staff working on the estuary feasibility study to coordinate on Capitol Lake issues relevant to both the estuary and TMDL study.
- Provided Doug George (USGS) with historical sediment information.
- Provided Percival Creek flow estimates to Bob Barnard (DFW) and discussed limitations of historical records and current low-flow patterns in December.

Model Development

Meteorology data, including sunrise and sunset, wind speed, solar radiation, and cloud cover, have been compiled from National Weather Service and related agencies for the period of interest.

Project air temperature data were compared with the Olympia Airport National Weather Service data. Air temperatures do not indicate a strong trend with river mile during the calibration period, and the elevation difference through the modeled reaches would produce only a small 0.5°C temperature variation, calculated from an adiabatic lapse rate of 6.5°C/1000 m. The air temperature at the project station nearest the Olympia Airport at river mile 6.8 is 1.5°C cooler than the airport station, which is reasonable given the influence of the river on local air temperatures and the extent of impervious surface at the airport. For modeling purposes, the project air temperature data will be averaged by hour across all monitoring stations for each of the calibration and validation time periods. These combined study area hourly averages will be used to develop daily minimum and maximum air temperatures for all river reaches.

J.E. Edinger and Associates, Inc., now known as ERM, Inc., continues to develop the Capitol Lake and Budd Inlet hydrodynamic and water quality model. ERM has added the capability to simulate pH into the model. Therefore, while the QAPP listed QUAL2KW as the model to be used for Capitol Lake pH, now the modified GEMSS model will be used to simulate both dissolved oxygen and pH in the combined Capitol Lake and Budd Inlet system. The draft model will be delivered to Ecology for final calibration and validation in spring 2006.

Project Schedule and Upcoming Tasks

All data collection but the stormwater monitoring program were completed in December 2004. In addition to completing remaining data collection, we will begin analyzing data and preparing water quality models:

- Track storms for potential wet-weather sampling events.
- Continue to maintain long-term Deschutes River temperature monitoring stations at Henderson Rd., the USGS gage at Rainier, and downstream of the Vail Tree Farm.
- Continue developing QUAL2KW model of the Percival system and continue with the development of the Deschutes River QUAL2KW model for temperature, DO, and pH.
- In late spring, we will request the future Capitol Lake bathymetry from USGS to use for Capitol Lake/Budd Inlet modeling.

We distributed the previous quarterly report via the Deschutes website in August 2005. The next quarterly report will be prepared and distributed in April 2006.

We have revised the overall project schedule to reflect longer external review times and additional time for Deschutes River and Capitol Lake/Budd Inlet model development. We expect to distribute the draft technical report in September 2006, and the final report is due to EPA for approval in June 2007.

References

Mantua, N.J, S.R. Hare, Y. Zhang, J.M. Wallace, and R.C. Francis. 1997. A Pacific interdecadal climate oscillation with impacts on salmon production. *Bulletin of the American Meteorological Society*, Vol 78, p. 1069-1079. Available online at http://www.atmos.washington.edu/~mantua/REPORTS/PDO/pdo_paper.html.

Tables and Figures

Table 1. Historical and recent flow conditions (cfs) in the Deschutes watershed. Negative Pacific Decadal Oscillation (PDO) climate signals are associated with higher regional river discharge. Positive PDO climate signals are associated with lower regional river discharge.

Time period	Statistic	Rainier USGS gage 12079000	E Street bridge USGS gage 12080010
Historical river discharge			
1945-1964 (negative PDO)	7Q10	--	78.3
1949-1964 (negative PDO)	7Q10	26.0	--
1991-2001 (positive PDO)	7Q10	21.4	56.3
TMDL study period river discharge			
2003	minimum 7-day avg Q	19	52
2004	minimum 7-day avg Q	24	60
Model calibration and validation time periods			
7/27/03-8/2/03 (calibration)	7-day avg Q	22.6	72.0
8/5/03-8/11/03 (validation cool)	7-day avg Q	23.9	69.4
8/20/03 (TIR flight)	1-day avg Q	24.0	65.0
7/21/04-7/27/04 (validation hot*)	7-day avg Q	31.1	78.9
8/10/04-8/12/04 (DO calibration)	3-day avg Q	27.7	74.3

*time period will be used only if method can be developed to reconstruct 2004 tributary temperatures.

Table 2. Preliminary flow summary from 8/6/03 synoptic survey.

River mile from mouth	Name	Type	Q (cfs)
42.3	**headwater**	**mainstem**	**12.2**
	Thurston Creek	tributary	1.7
	Johnson Creek	tributary	0.2
	Huckleberry Creek	tributary	0.5
	Mitchell Creek	tributary	2.1
	Fall Creek	tributary	0.3
	difference	*distributed inflow*	*+5.0*
37.4	**1000 Road**	**mainstem**	**17.2**
	Hull/Pipeline Creek	tributary	estimate
	Lake Lawrence	tributary	estimate
	Reichel Creek	tributary	0.2
	507 spring	tributary	3.3
	difference	*distributed inflow*	*+3.1*
24.9	**USGS Rainier gage**	**mainstem**	**23.8**
	Silver spring	tributary	2.0
	Spurgeon Creek	tributary	2.2
	Ayer Creek	tributary	estimate
	Chambers Creek	tributary	1.2
	difference	*distributed inflow*	*+50.0*
00.5	**USGS E St gage**	**mainstem**	**79.2**

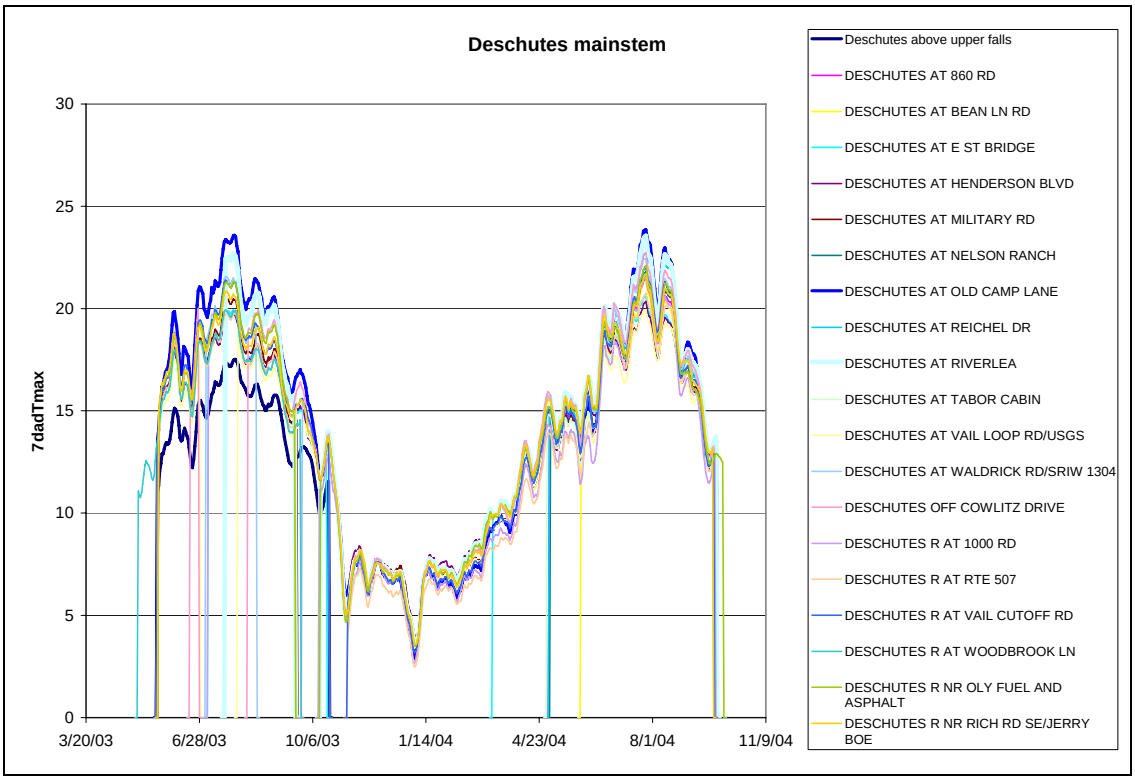

Figure 1. Seven-day average of daily maximum temperatures for stations along the main stem of the Deschutes River for 2003 and 2004.

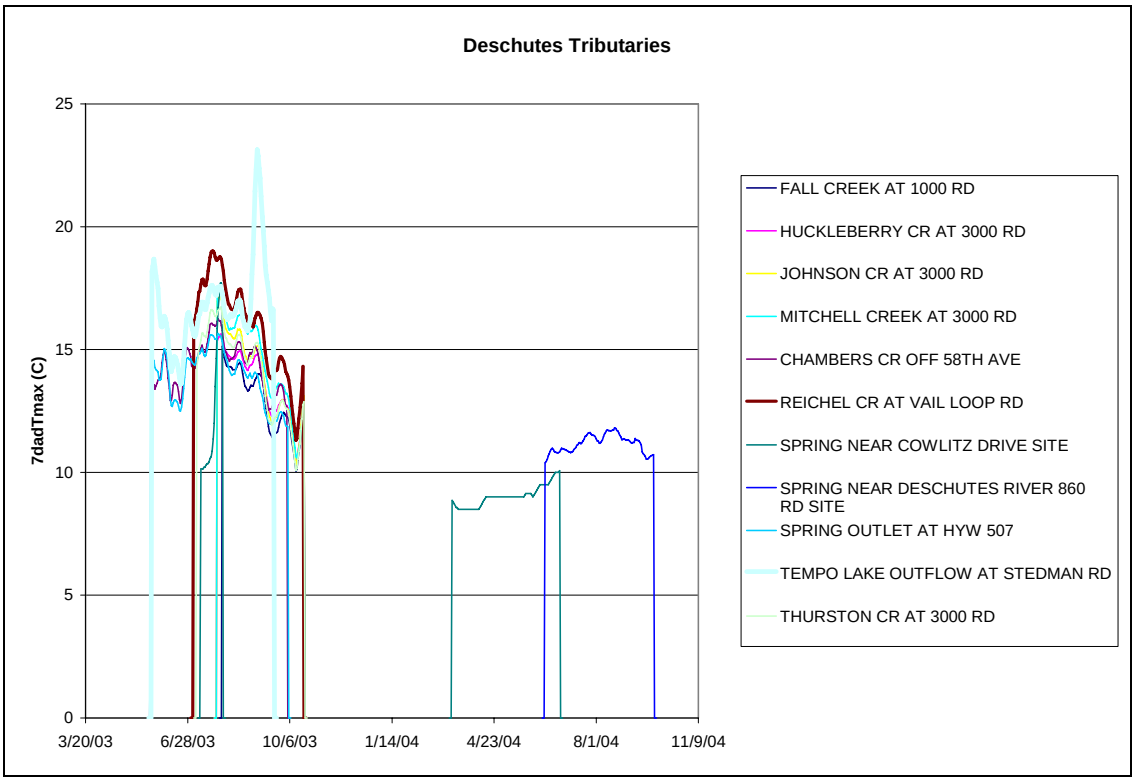

Figure 2. Seven-day average of daily maximum temperatures for stations on tributaries and spring inflows to the Deschutes River for 2003 and 2004.

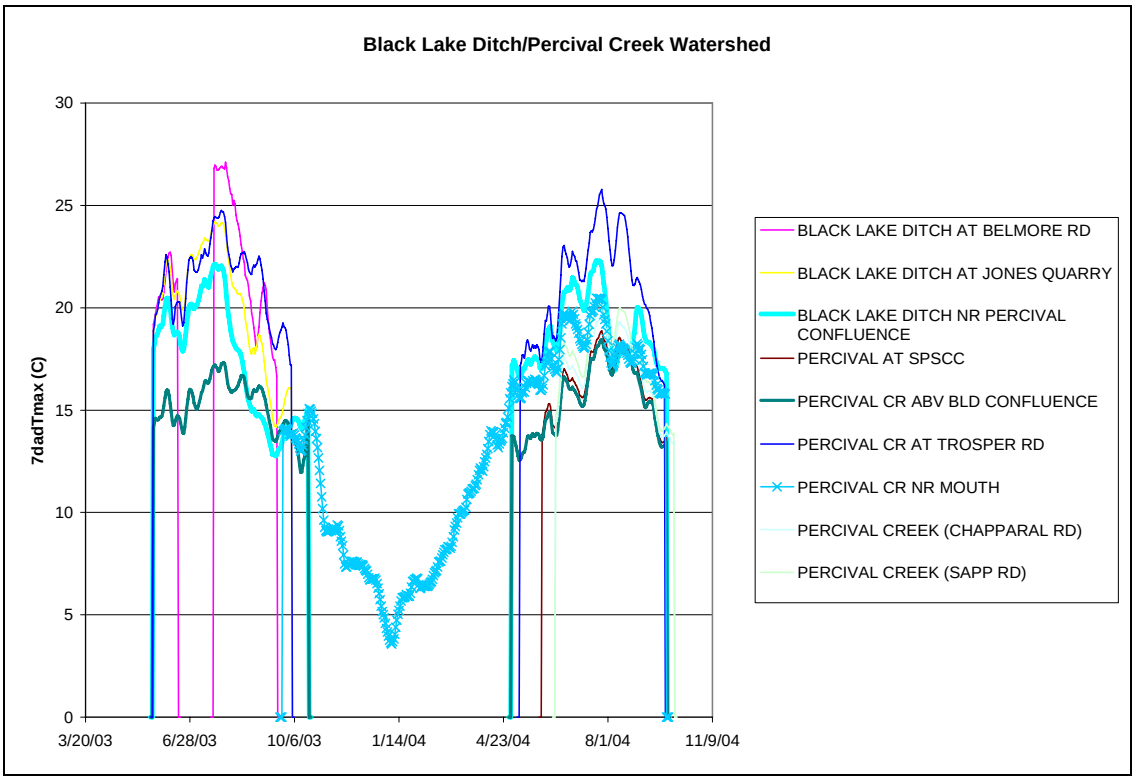

Figure 3. Seven-day average of daily maximum temperatures for stations on Percival Creek and Black Lake Ditch for 2003 and 2004.

Comparison of stream seepage values, vertical hydraulic gradients, and daily mean stream temperature during the August 5, 2003 Deschutes R. seepage run

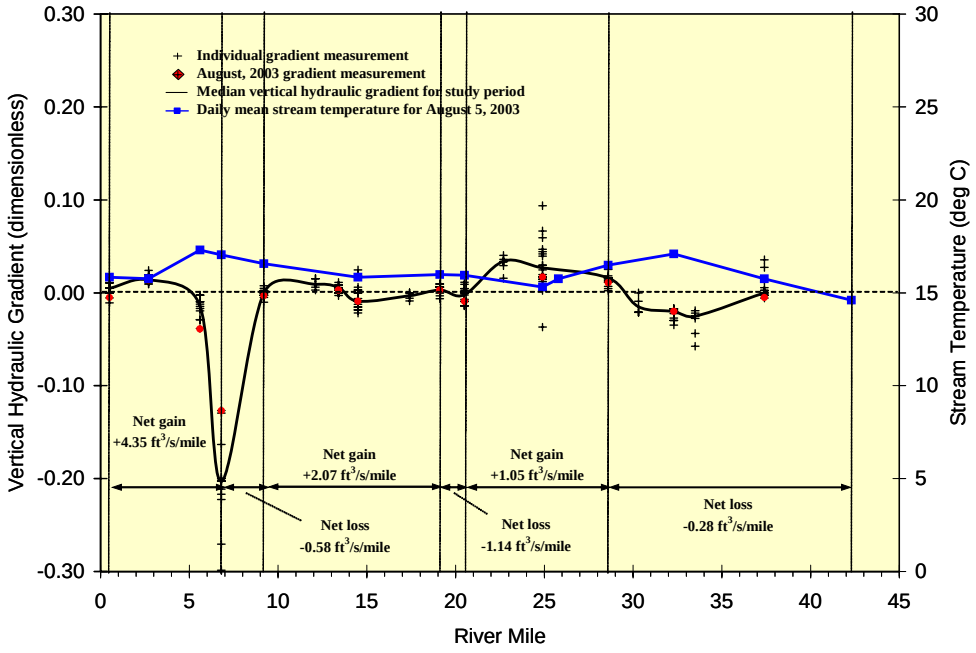

Figure 4. Longitudinal profile of Deschutes River temperature and vertical hydraulic gradient within piezometers installed in streambed.